9.1 Engineering Treatments

The following are conceptual designs that could be considered. Conceptual designs to be reviewed in context."

Intersection Treatments

Simplify or Close Approach

Under the treatment, a minor approach to an intersection is closed to traffic, restricted to a single direction, or realigned to simplify movements. Generally, treatment is applied to approaches with low vehicle volumes. Movements that are impacted should be reviewed to understand potential to reroute vehicle traffic. Treatment frequently allows for installation of curb extensions.

Safety Impacts

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Eliminates higher-risk movements, such as a turn movement with restricted visibility.
- Can shorten and simplify crossing movements for people walking and biking.
- Increases visibility between drivers and people walking and biking.
- Can improve intersection operation by reducing queuing behind turning vehicles.

Predicted Crash Reduction

Impact varies based on specific conditions.

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
Town Access Road	Side Street Stop Controlled	Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$$$	20 years	Low

Additional Resources:

ITE Toolkit: https://toolkits.ite.org/uiig/treatments/40%20Close%20Intersection%20Leg.pdf

Centerline Hardening / Splitter Island

A raised treatment on an intersection approach that reinforces travel lanes. The goal of the treatments is to reinforce appropriate travel patterns rather than change how motorists, pedestrians, or cyclists navigate through an intersection.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Slows left-turning vehicles without reducing traffic capacity.
- Discourages drivers from "cutting" corner for safer and more predictable turns.
- Increases visibility of people walking in the crosswalk to turning drivers.

Predicted Crash Reduction

68%

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=2936

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	**Skewed Approach / Large Radius**	Transit Corridor
	Primary Rural Intersection	Historic Context

Sources: *City of Boston (left) and Kittelson & Associates, Inc. (right)*

Relative Cost	Lifespan	Potential for Systemic
$-$$	20 years	Medium

Additional Resources:

City of Boston (Centerline Hardening): https://www.boston.gov/departments/transportation/street-planning-and-design-glossary#street-safety-tools

ITE Toolkit (Splitter Island): https://toolkits.ite.org/uiig/treatments/50%20Splitter%20Island.pdf

Roundabout / Mini Roundabout

A roundabout is a form of circular intersection in which traffic travels counterclockwise around a central island and in which entering traffic must yield to circulating traffic. Treatment can be applied in a range of contexts from urban to rural and can be used in higher and lower speed environments. Installation may be impractical if the location has existing land uses that abut roadway.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Reduces the angle of crashes, reducing most severe crashes (no "T-bone" crashes)
- Slow down vehicles using roadway curvature

Predicted Crash Reduction

44%

Reduction in all injury-related crashes

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=9157

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$$$	20 years	Low

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/roundabouts

Install/Convert to All-Way Stop

At side-street or minor approaches stop-controlled intersections stop signs are installed at all approaches. Treatment reduces roadway capacity where stop signs are installed; however, treatment can improve overall operation by reducing back-ups on minor approaches.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	***Manage Conflicts in Time***	*Increase Attentiveness and Awareness*

- Reduces potential for crashes associated with vehicles turning from stop-controlled legs, particularly where curves or built environment limit visibility at intersection.
- Reduces potential for crashes at four leg intersections, including intersections with off-set approaches, where vehicles cross an uncontrolled movement.
- Facilitates frequent people walking in crosswalks and reduces potential for severe injuries by reducing motor-vehicle speeds.

Predicted Crash Reduction

75%

Reduction in angle crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=310

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$	10 years	Low

Reduce Intersection Radii

Treatment includes curb extensions (reduces radii by expanding curb line) and realignment of an approach to make it closer to perpendicular to intersecting roads. Treatment can be completed using modular devices or with more permanent changes involving changes to pavement and curb. Treatment is appropriate in urban and rural contexts. See Curb Extension treatment sheet for description of how curb extensions can be targeted for pedestrian safety improvements.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Reduces potential for severe crashes by slowing turning vehicles.
- Reduced turning speeds can reduce crash frequency by improving yielding.

Predicted Crash Reduction

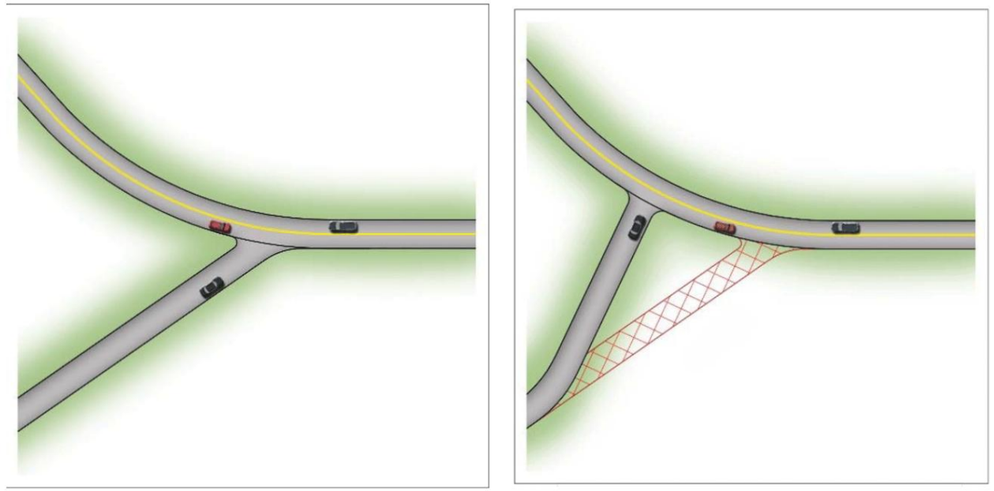
44%

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=8496

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	**Skewed Approach / Large Radius**	**Transit Corridor**
	Primary Rural Intersection	Historic Context



Source: *FHWA*

Relative Cost	Lifespan	Potential for Systemic
$$-$$$	5-20	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/rwd/keep-vehicles-road/horizontal-curve/low-cost-treatments-horizontal-curve-safety-2016-7

ITE Toolkit: https://toolkits.ite.org/uiig/treatments/44%20Realign%20for%20Skew.pdf

NACTO Guidance: https://nacto.org/publication/dont-give-up-at-the-intersection/dedicated-intersections/reducing-turn-speeds-and-mitigating-conflicts/

Nantucket-Approved Intersection Lighting

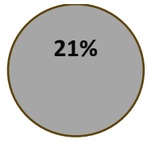
Placing lighting at an intersection or along a corridor helps to improve visibility of motor vehicles and people walking and biking during low light conditions. In rural context, lighting can alert drivers that an approaching intersection and potential for turning vehicles. Lighting can also encourage foot traffic and can make local establishments feel inviting.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Improves the visibility of people walking in crosswalks.
- Along roads with few intersections, lighting can increase awareness of approaching intersections and increase sight distance.

Predicted Crash Reduction



Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=10993

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$$-$$$	20 years	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/lighting

Larger or Additional Signage Warning / Regulatory Signs

Signage approaches used to elevate warnings around intersections or other higher-risk locations. Treatment should be used as targeted locations where standard signs are found to be insufficient. Overuse of treatment has potential to reduce effectiveness. Treatments include:

- Replace existing signs with large warning/regulatory signs.
- Place signage on both sides of the roadway.
- Install advance warning signs on stop-controlled approaches.
- Install intersection advance warning / frequent turn signs on major approaches.
- Augment signs with flashing beacons.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Alert drivers to approaching intersections or other conflict zones that may be hard to see or out of sight due to roadway curvature.

Predicted Crash Reduction

35%

Reduction in angle crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=1684

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
Town Access Road	Side Street Stop Controlled	Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *FHWA*

Relative Cost	Lifespan	Potential for Systemic
$	10 years	High

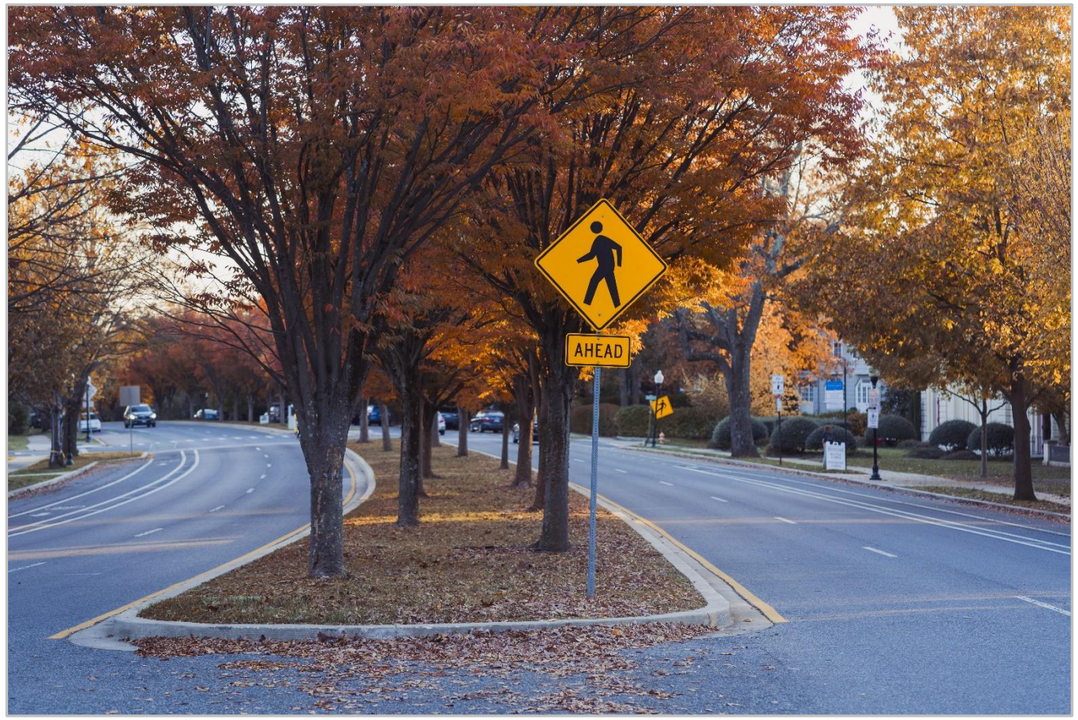
Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/systemic-application-multiple-low-cost-countermeasures-stop

Roadway Treatments

Raised Median

This treatment involves installing raised objects, such as curbs, between lanes of traffic to separate opposing movements. The treatment can be applied along roadways and along the approach to intersections, such as at roundabouts. The treatment is designed to limit turning movements across roadways and lane departure where vehicles drift across a center median. The treatment can be paired with Pedestrian Median Islands to support pedestrian safety. Landscaping in medians should not obstruct the visibility between people in crosswalks and drivers.



Source: *Kittelson & Associates, Inc.*

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Provides physical separation on high volume and high-speed roads, reducing the potential for head-on crashes.
- Restricts locations for left turns which can help to eliminate turning movements, such as mid-block left turns from driveways, that tend to have higher risk.

Predicted Crash Reduction

71%

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=2219

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Relative Cost	Lifespan	Potential for Systemic
$-$$$	20 years	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/medians-and-pedestrian-refuge-islands-urban-and-suburban-areas

Access Management

The treatment includes a suite of approaches used to manage entry and exit points along a roadway. Typically applied on commercial corridors where there is a higher density of driveways or where a driveway is set adjacent to intersections. Measures include:

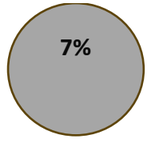
- Limiting left-turn movements to and from driveways using raised medians.
- Consolidating/moving driveway entrances to reduce conflict points and ensure clearance from intersections.
- Restricting driveway access where a driveway/parking lot could be used as a bypass route.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Consolidating turning locations reduces conflict locations.
- Reduces risk for people walking and biking by reducing driveway conflicts.

Predicted Crash Reduction

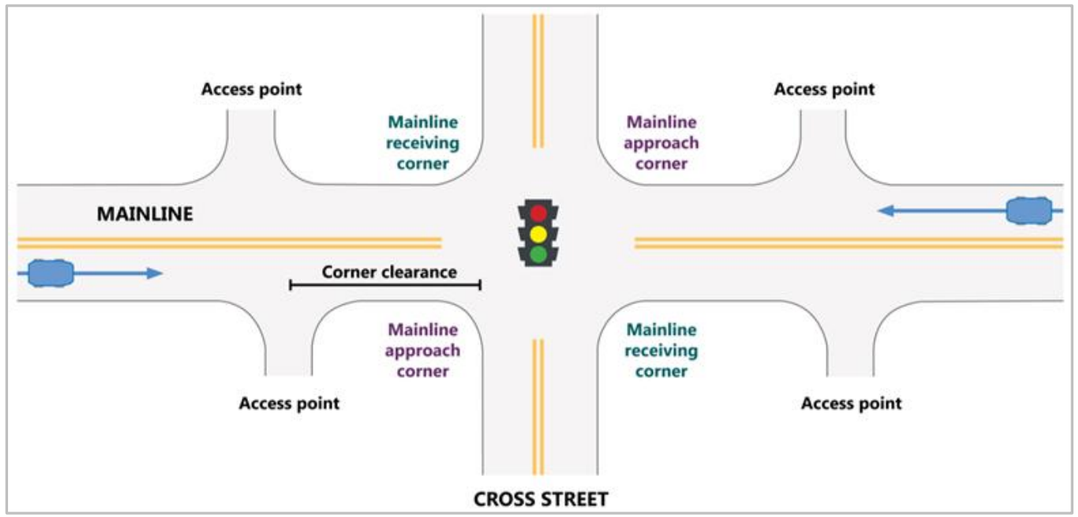


Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=442

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context



Source: *FHWA*

Relative Cost	Lifespan	Potential for Systemic
$$$	20 years	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/corridor-access-management

Transverse Rumble Strips

The treatment typically consists of grooves crossing the roadway surface in the travel lane. In contrast to edgeline or centerline rumble strips, drivers are intended to drive over grooves on their normal path. The grooves provide a tactile and audible warning for drivers in rural areas that they are approaching an intersection or reduced speed zone.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Noise and vibration alert the driver to changing conditions to the roadway.
- Effective at night when higher potential for inattentive driving or where signage may be less visible.

Predicted Crash Reduction

26%

Reduction in all injury-related crashes

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=2705

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
Town Access Road	Side Street Stop Controlled	Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *FHWA / MnDOT*

Relative Cost	Lifespan	Potential for Systemic
$	10 years	High

Additional Resources:

FHWA Guidance: https://www.fhwa.dot.gov/publications/research/safety/hsis/12047/index.cfm

Speed Feedback Signs

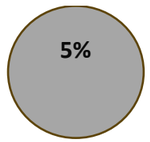
A speed feedback sign identifies the speed limit and reports speed to drivers relative to limit. Signs use flashing lights or other features to notify drivers when their speeds exceed the posted limit. Speed feedback signs can be used at locations with a history of speeding and/or where speed limit changes quickly, such as when approaching town or curve.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Informs drivers that exceed speed limit to encourage lowering of speeds.

Predicted Crash Reduction



Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=6885

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *FHWA Methods and Practices for Setting Speed Limits Informational Report*; Kittelson & Associates, Inc.

Relative Cost	Lifespan	Potential for Systemic
$	10 years	Medium

Edgeline / Reduce Lane Width

Edgelines are painted lines that increase the visibility of travel lane boundaries. For example, they can be used to set the travel lane around curves, or where there are risks located just beyond the roadway, such as trees. Edgelines can also be employed to visually reduce the width of the road and identify a preferred travel line. This use has the potential to encourage slower travel speeds are create space between vehicles and the edge of the road where there is more potential for conflict with people biking or parking.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Increases visibility of road edge and shoulder during both daytime and low-light conditions.
- Can designates space for people biking on the roadway shoulder (see Bicycle Routes).
- Encourages lower average driving speeds.

Predicted Crash Reduction

- Edgelines: 18% reduction in all crashes of all severities
  https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=4736
- Reduce Lane Width: 42% reduction in all crashes of all severities
  https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=7827

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
Town Access Road	Side Street Stop Controlled	**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *FHWA (left) and Google (right)*

Relative Cost	Lifespan	Potential for Systemic
$-$$	varies	Low

Additional Resources:

FHWA Guidance: Reducing Lane Width

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/wider-edge-lines

Gateway Signage

This treatment adds stylized signs at the edge or spanning major arterials where motor vehicles are entering a town or village center. The signs help to alert drivers to changing conditions and the potential need to reduce speeds. They can also help with wayfinding by announcing arrival to a destination, alerting drivers that their destination may be approaching.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Provides indication of changing conditions and the potential need to reduce speeds.

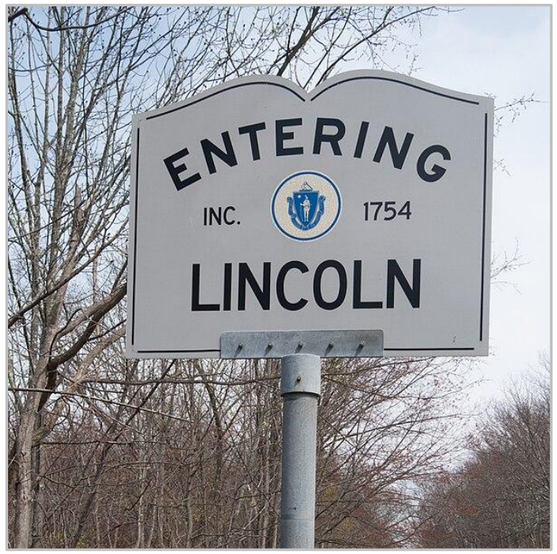
Predicted Crash Reduction

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=2430

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context



Source: *Wikipedia*

Relative Cost	Lifespan	Potential for Systemic
$-$$	Varies	Low

Edgeline Rumble Strips / Centerline Rumble Strips

Rumble strips use noise and vibration to warn drivers when they leave the travel lane. Edgeline rumble strips are used to warn drivers departing to the outside and centerline rumble strips are installed to warn drivers before they cross into on-coming traffic. Treatments may not be appropriate in heavily populated areas as noise generated by vehicles traveling over grooves. Relative to edgeline rumble strips, centerline rumble strips are targeted at more severe crashes (head-on crashes).

Source: *FHWA*

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Uses noise and vibration to enhance driver awareness of the roadway by deterring drivers from veering outside of the travel lane.
- Alerts drowsy drivers when they depart lanes as well as drivers traveling under low visibility.

Predicted Crash Reduction

20%

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=6850

Relative Cost	Lifespan	Potential for Systemic
$-$$	10 years	High

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/longitudinal-rumble-strips-and-stripes-two-lane-roads

Curve Warning Treatments

A suite of improvements to increase the visibility of horizontal curves. These treatments include:

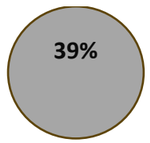
- Curve Advance Warning Signs: Advance warning signs to warn drivers of approaching curve.
- Chevrons: Series of signs placed at regular intervals along a curve. Used when appropriate speed along curve is lower than on road approaching curve.
- Delineators: Reflectors placed along a curve to call attention to a curve and assist operators in navigating a curve particularly in low light. The treatment tends to be used at locations where curves do not require a substantial reduction in travel speeds.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Encourages appropriate speeds and increased attentiveness of horizontal curves, such that drivers do not depart the travel lane.

Predicted Crash Reduction



Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=1851

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *FHWA*

Relative Cost	Lifespan	Potential for Systemic
$	Varies	High

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/enhanced-delineation-horizontal-curves

FHWA Guidance: https://www.fhwa.dot.gov/publications/research/safety/09045/

Pedestrian-Focused Treatments

Pedestrian Median Islands

A pedestrian median island is a protected area in the middle of a crosswalk that provides a protected space for people to stop while crossing the street. Often installed with other Enhanced Crosswalk Markings. Designs must have 6 feet of clear width to accommodate people in wheelchairs.

Source: *Kittelson & Associates, Inc.*

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Provide a protected location for people in crosswalk to use when crossing a road.
- Enables people walking to cross only one direction of travel at a time, improving awareness of oncoming vehicular traffic and reducing crossing distances.
- By reducing travel lanes, tends to reduce motor-vehicle travel speeds.

Predicted Crash Reduction

26%

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=8800

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Relative Cost	Lifespan	Potential for Systemic
$	20 years	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/medians-and-pedestrian-refuge-islands-urban-and-suburban-areas

NACTO Guidance: Pedestrian Safety Islands

Trail Crossings and Trail Edge Treatments

At crossing locations, consider other **pedestrian-focused crossing treatments**, such as Curb Extensions and Rectangular Rapid Flashing Beacons. Use **consistent signs and marking at roadway crossings** to encourage more consistent travel and yielding behavior by trail users and drivers.

Along trails, the edge of the trail should be separated from the roadway by **planted break** or **raise edge** that physically separate facilities and trail users from general traffic. These design elements are also useful for discouraging illegal parking on trails.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Improves the visibility of people crossing the street and increases driver yielding behavior.
- Warns drivers in advance of trail crossing.
- Reduce potential for crashes where trail users cross into roadway or motor-vehicles impede on trail.

Predicted Crash Reduction

Impact varies based on specific conditions and treatments.

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *bikepedinfo.org*

Relative Cost	Lifespan	Potential for Systemic
$$-$$$	Varies	Medium

Additional Resources:

FHWA Guidance: https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

Sidewalks

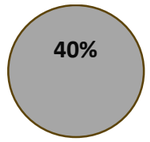
A dedicated facility adjacent to the roadway and separated from traffic by a curb. Landscape buffers or wider sidewalks may be desirable depending on surrounding land use context. In more rural areas, they may be targeted to locations where there are known destinations that attract people walking, such as schools and transit stops. Provides means of mobility for people using wheelchairs, strollers, or others who may not be able to travel on an unpaved surface.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Provides secure locations for people to walk separated from vehicle traffic.
- Reduces potential crashes involving people walking on edge of roadway.

Predicted Crash Reduction



Reduction in vehicle/pedestrian crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=11246

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context

Source: *Nelson\Nygaard*

Relative Cost	Lifespan	Potential for Systemic
$-$$$	varies	Low

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/walkways

Curb Extensions

This treatment involves reducing the width of the roadway at intersections or mid-block crossings using wider sidewalks, landscaped buffers, or other vertical delineation. The treatments increase the available space for pedestrian amenities and shorten crossing distances for people walking. Curb extensions reduce the available turning radii for motor-vehicles, generally resulting in slower speeds for right-turning vehicles.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Shortens crossing distances for people walking.
- Increases visibility of pedestrians, particularly where there is on-street parking, by moving the edge of the sidewalk closer to the vehicle travel lane.
- Slows vehicles by reducing the turning radii for right-turning vehicles.
- May reduce average travel speeds for all vehicles by creating a visual pinch.

Predicted Crash Reduction

Treatment impacts vary based on conditions.

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
	Side Street Stop Controlled	
Town Access Road		Bikeway and Trails
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$-$$	Varies	Low

Additional Resources:

NACTO Guidance: https://nacto.org/publication/urban-street-design-guide/street-design-elements/curb-extensions/

Raised Crosswalk

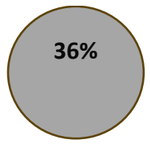
This treatment raises the entire intersection or crosswalk to be level with the sidewalk. It may not be appropriate where sight distance is limited such that drivers are not able to identify features and modify their speed. Design should be coordinated with bus or emergency services.

Safety Impact

Remove Severe Conflicts	***Reduce Vehicle Speeds***	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Reinforces slower vehicle speeds through a grade change.
- Encourages motorists to yield to people in crosswalks by elevating individuals crossing the road relative to vehicles, making them more visible.
- In the event of a collision, raising people walking to higher level can lessen severity of impact from motor vehicles.

Predicted Crash Reduction



Reduction in all injury-related crashes

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=135

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
Town Access Road	**Side Street Stop Controlled**	**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$	20 years	Medium

Additional Resources:

FHWA Guidance: https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RaisedCW2018.pdf

NACTO: https://nacto.org/publication/urban-street-design-guide/intersections/minor-intersections/raised-intersections/

NACTO: https://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements/speed-table/

Rectangular Rapid Flashing Beacon (RRFB)

Treatment includes signs placed on either side of a crosswalk with a pedestrian-activated flashing light to increase awareness of people walking or biking at crosswalks at uncontrolled locations. Signs are placed at either side of the crosswalk. Treatment should be prioritized on roads with higher pedestrian volumes, such as at trail crossings as over-use may diminish effectiveness. Treatment is not intended for use at crosswalks with stop, yield, or traffic signals.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	***Manage Conflicts in Time***	*Increase Attentiveness and Awareness*

- Informs drivers of the presence of pedestrians in a crosswalk to encourage yielding.
- Yielding rates diminish with higher average vehicle speeds.

Predicted Crash Reduction

69%

Reduction in vehicle/pedestrian crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=11158

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	**Transition Zone**
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$	20 years	Medium

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/rectangular-rapid-flashing-beacons-rrfb

Enhanced Crosswalk Markings

Crosswalks painted with bar pairs, continental, and ladder patterns that are more visible to both the diver and people crossing than transverse lines (i.e., two parallel lines set perpendicular across the roadway). On roads with moderate to high vehicle volumes or at mid-block locations may augment the crosswalk with:

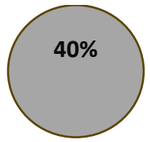
- Added lighting placed on approach to crosswalk which illuminates those in crosswalks.
- Signs placed at crosswalks that emphasize crossing location.
- Painted messages and stop / yield bars that indicate where drivers should stop / yield.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Increases driver awareness of people in crosswalks.
- Encourages slower and more attentive driving due to the legal requirement for drivers to stop for people walking in a crosswalk.

Predicted Crash Reduction



Reduction in all vehicle/pedestrian crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=4123

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$-$$$	20 years	High

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/crosswalk-visibility-enhancements

NACTO: https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/conventional-crosswalks/

Bicycle-Focused Treatments

Separated Bicycle Lanes

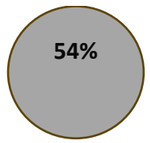
Bicycle lane separated from vehicle traffic by a physical barrier such as planters, flexible posts, parked cars, or a curb. Bicycle travel may be one-way or two-way (two-way can also be referred to as a “cycle track”). Appropriate buffer type may vary on roadway context (e.g., parking protected bike-lanes require on-street parking).

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Separates bicycles from vehicle traffic, reducing potential for crashes involving motor-vehicles and people biking, such as side-swipe crashes and “dooring”, where a person in a parked vehicle opens a door into a bicyclist.
- Implementation tends to reduce width of motor-vehicle travel lane, which may result in lower vehicle speeds.

Predicted Crash Reduction



Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=11553

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
Town Access Road	Side Street Stop Controlled	**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc*

Relative Cost	Lifespan	Potential for Systemic
$-$$	20 years	High

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/bicycle-lanes

NACTO: https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/

Shared-Use Path

Treatment is a separate facility outside of the roadway for people walking and biking. Where possible trails are generally 12 feet across and located in areas where roadways crossings and driveway crossings are limited. Paths serve both recreation and transportation and are appropriate for all ages and abilities. They can be links between communities or parallel, alternative routes to roads in areas where sidewalks or on-street facilities are not provided. Relative to separated bike paths, may require additional right-of-way.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	*Increase Attentiveness and Awareness*

- Separates people walking and biking from vehicle traffic, reducing potential for crashes involving motor-vehicles and people traveling in the roadway by foot or bike.
- Potential to create alternative routes that allow people walking and biking to avoid crossing roadways (e.g., rails-to-trails project where paths are built on old rail right-of-way).

Predicted Crash Reduction

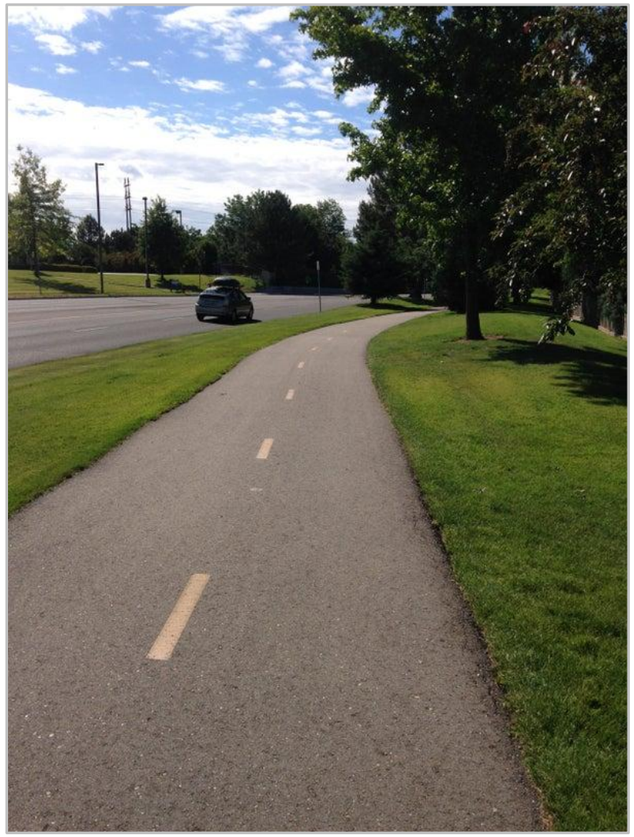
25%

Reduction in all vehicle/bicycle crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=9250

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
Town Access Road	Side Street Stop Controlled	**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	**Transit Corridor**
	Primary Rural Intersection	Historic Context



Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$$-$$$	20 years	Low

Additional Resources:

FHWA Guidance: https://www.fhwa.dot.gov/publications/research/safety/05139/index.cfm

Buffered Bike Lanes

Buffered bike lanes are on-street bike lanes that include an additional striped buffer (typically 2-3 feet) between travel lanes or parked vehicles. The buffer may be augmented with rumble strips in more rural contexts to deter vehicles from using the buffer space. They are typically applied on roads with moderate vehicle speeds or volumes which provide a desirable route for people biking (such as a link within or between communities).

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Encourages additional separation between motorists and people biking, reducing the potential for conflicts with moving vehicles and parked vehicles.

Predicted Crash Reduction

- Impact varies based on specific conditions.

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$-$$	Varies	High

Additional Resources:

FHWA Guidance: https://highways.dot.gov/safety/proven-safety-countermeasures/bicycle-lanes

NACTO: https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/buffered-bike-lanes/

Bicycle Routes (Wider Shoulder and/or Signage)

This treatment includes a suite of treatments for improving facilities for people biking on roads in more rural areas, where bicycle use may be lower or seasonal. The treatments include installing signs that notify drivers to share the roads, using edgelines to establish a wider shoulder for people biking, and adding rumble strips to reinforce the edgelines for motor-vehicles. Signs should be installed with consideration for locations where people biking further up the road may be hidden by turns or vegetation.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Signs increase awareness that people driving may need to adjust speed to navigate people biking and reinforce that it is appropriate for people to be biking on road.
- Wider shoulders provide greater recovery time for drivers who leave the roadway and a dedicated space for people biking.

Predicted Crash Reduction

Reduction in all crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=7755

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	Complex Intersection / Rotary	Transition Zone
	Side Street Stop Controlled	
Town Access Road		**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$	5 years	High

Additional Resources:

FHWA Guidance: https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf

Bicycle Markings through Intersections

This treatment uses paint in “conflict zones” where vehicles and bicycles may intersect to highlight the presence of people biking. Best used in conjunction with other bike lane treatments, it indicates to drivers the potential for conflicts with people biking. White dashed lines should be used at a minimum to extend a bike lane through an intersection or across a conflict zone and dashed green pavement can enhance driver awareness and bicyclist visibility.

Safety Impact

Remove Severe Conflicts	*Reduce Vehicle Speeds*	*Manage Conflicts in Time*	***Increase Attentiveness and Awareness***

- Increases driver awareness and predictability of people biking.

Predicted Crash Reduction

39%

Reduction in all vehicle/bicycle crashes of all severities

https://cmfclearinghouse.fhwa.dot.gov/detail.php?facid=3258

Recommended for Typologies

Corridor	Intersections	Overlay
Town Street	**Complex Intersection / Rotary**	Transition Zone
Town Access Road	**Side Street Stop Controlled**	**Bikeway and Trails**
	Split Approach Intersection	
Rural Connector	Skewed Approach / Large Radius	Transit Corridor
	Primary Rural Intersection	Historic Context

Source: *Kittelson & Associates, Inc.*

Relative Cost	Lifespan	Potential for Systemic
$	Varies	Medium

Additional Resources:

FHWA Guidance: https://safety.fhwa.dot.gov/intersection/about/fhwasa22017.pdf

NACTO: https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/intersection-crossing-markings/